**Project Description:**

"Sudoku 2" is a game of sudoku puzzles that includes a neural network that can read a handwritten sudoku board. It can take get new puzzles for you to play using web scraping, solve the puzzles that you can't using backtracking, and give you a text file of your current board.

**Competitive Analysis:**

There are many other sudoku solving and playing services, like <https://www.sudokuwiki.org/sudoku.htm>, and <https://www.sudoku-solutions.com/>. However, most can not read handwritten sudoku boards. My project has a neural network along with image processing that allows it to read handwriting and can attempt to solve your handwritten boards for you as well.

**Structural Plan:**

My final project will be contained in 5 python files.

The python files will be 1 for the neural network to recognize the numbers, 1 for solving the sudoku puzzles with backtracking and checking if a board is legal, 1 for blob detection and for making each "blob" into something that the neural network can read, 1 for web scraping for new puzzles every time you restart the game, and 1 final runner file for the user interface so that the user can use the product.

In the zip file that I submit, there will also be some sample images to test the project with so that the user can test the neural network without having to take a picture themselves. There will also be Cmu112 graphics (the python file) that is needed for my graphics.

**Algorithmic Plan:**

The two tricky parts of my program are creating a neural network and writing a program for blob detection. They were two areas that I didn't have any experience in and were difficult to understand when I was beginning to code them, especially because I was coding them from scratch instead of using things like OpenCV and Keras.

The main algorithmic idea of the neural network is this: The program takes in some data and splits it into two sets, the training dataset (70%) and the testing dataset (30%). Then, it assigns each value of input (from the testing dataset) some weight and bias (kind of like m and b in y=mx+b where weight is m and bias is b). Then, it passes this info to another set of neurons that does the same thing. This happens once more and the final product is outputted. This output is a prediction. Then, loss (error) is calculated using the actual "answers" to the data from the training dataset for every layer of the network to see where the weights and biases were. Then, this loss is used to update the weights and biases in the network. Then, this process is repeated. After repeating several times, the weights and biases are fairly close to what they should be for the predictions to come relatively correctly. Then, to test this hypothesis, the testing data is sent through the network to get the testing accuracy. This number tells you how good your network is at predicting the answer when given some data.

Blob detection was the other majorly complex part of my project. In essence, my program takes an image, cuts it up into small pieces based on white space and then uses the image’s colour values (when converted to greyscale) to detect what is a number and where the number ends. Once the number is found, that area of the image is copied and the copy is made into an array of 1s and 0s to indicate where the writing is and where the blank page is. Then the numbers are scaled based on this array of 1s and 0s and resized to match the training data for my neural network. The numbers are then put into a list and send through my neural network to be identified.

Something other things that (slightly) add to the difficulty of my project are backtracking, which is recursion that solves puzzles recursively by trying every possible solution until it hits the right one, and web scraping, which is looking through a webpage to get information. Backtracking was used to solve the sudoku puzzles in my game and web scraping was used to find a new puzzle every time the game was restarted.

**Timeline Plan:**

Everything is done and working. If I have time, I can make the UI prettier.

**Version Control Plan:**

Versions of my project are saved on my Github (https://github.com/ShamikaD). In addition, I have been backing up my computer to a physical hard drive.

A screenshot of a social media post

Description automatically generated

**Module List:** numpy, matplotlib, PIL, requests, beautiful soup (bs4), and pandas